



Science Question

- There is a critical need to improve our understanding of organic aerosols (OAs). These represent a significant fraction (20-80%) of the ambient PM concentrations in urban, rural, and remote areas.
- Our current understanding of OAs is inadequate because the capabilities for their fast size-resolved chemical analysis have lagged behind that of most other aerosol components. Inherent challenges are the very small amounts of material, thousands of different compounds, and a very wide range of volatilities and polarities, from hydrocarbons to peroxides, acids, and humic-like substances.

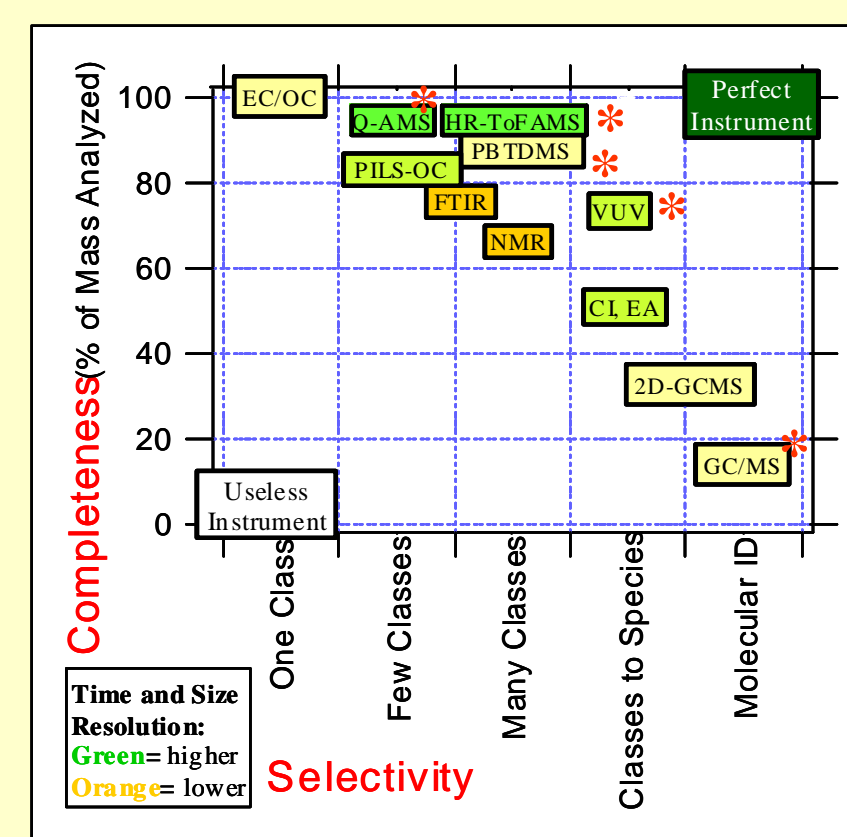
➤ Can we develop and use new analytical techniques to provide a quantum leap in our knowledge of the concentrations and sources of organic aerosols?

Research Goals

- In the last few years we have seen the emergence of a number of techniques with improved capabilities for organic aerosol characterization with high time and size resolution.
- The EPA PM Research Program has been at the forefront of supporting the development and application of new OA analysis techniques. This poster summarizes new developments and recent results.

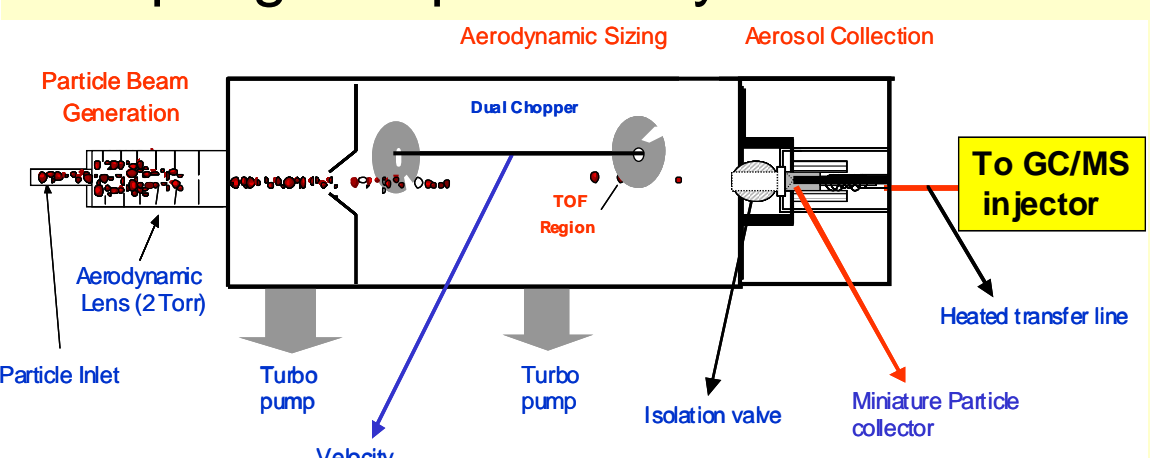
Overview of Techniques

- Below is a schematic representation of where existing and new techniques are in terms of the three most important qualities: selectivity, completeness, and time and size resolution. EPA-funded techniques are marked with a star (*).

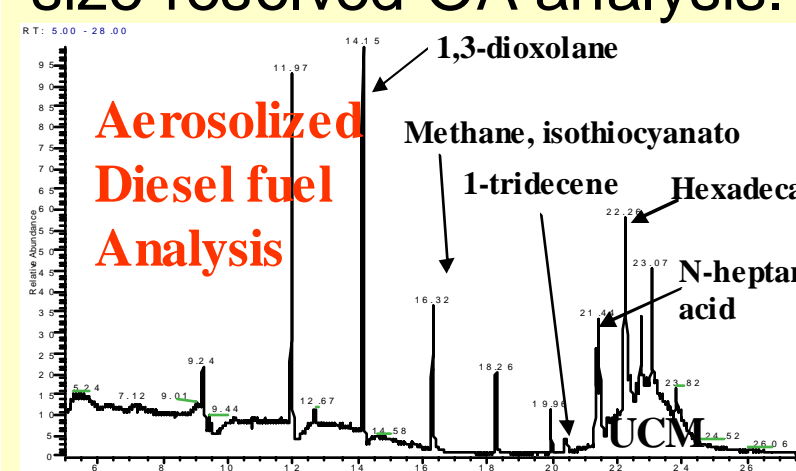


Real-Time GC-MS Analysis

- GC-MS remains a powerful method of identifying individual species. It has been plagued by sampling artifacts and low time resolution due to filter sampling and post analysis.

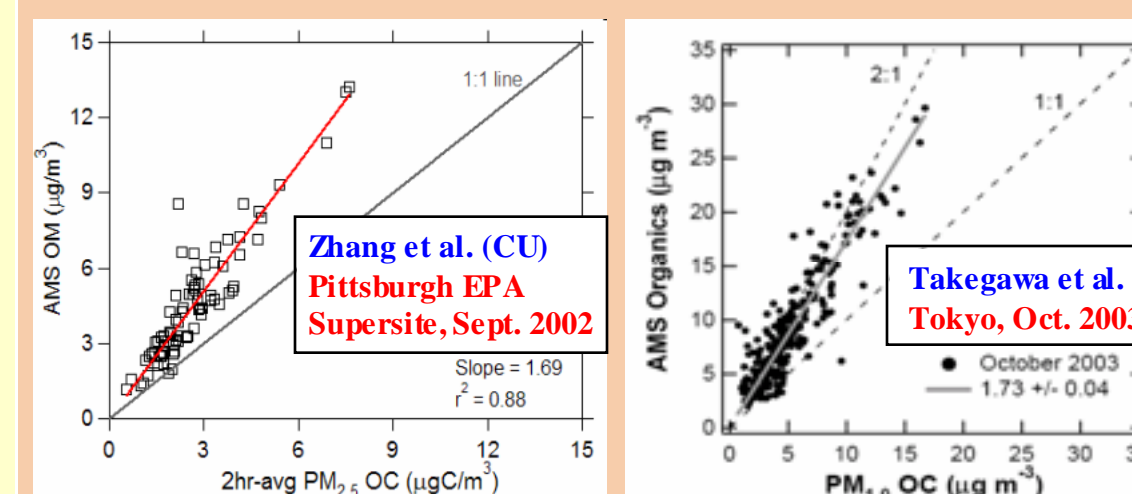


- MIT and Aerodyne are developing an aerosol collector for fast real-time & size-resolved OA analysis. A chromatogram from this system is shown here.

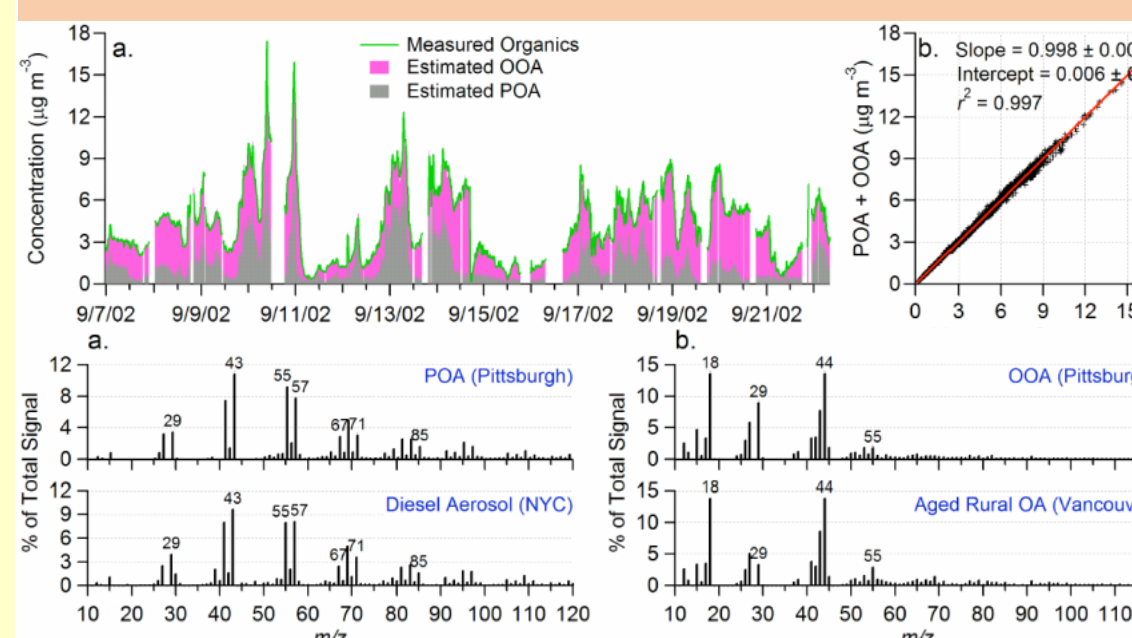


Aerosol Mass Spectrometer

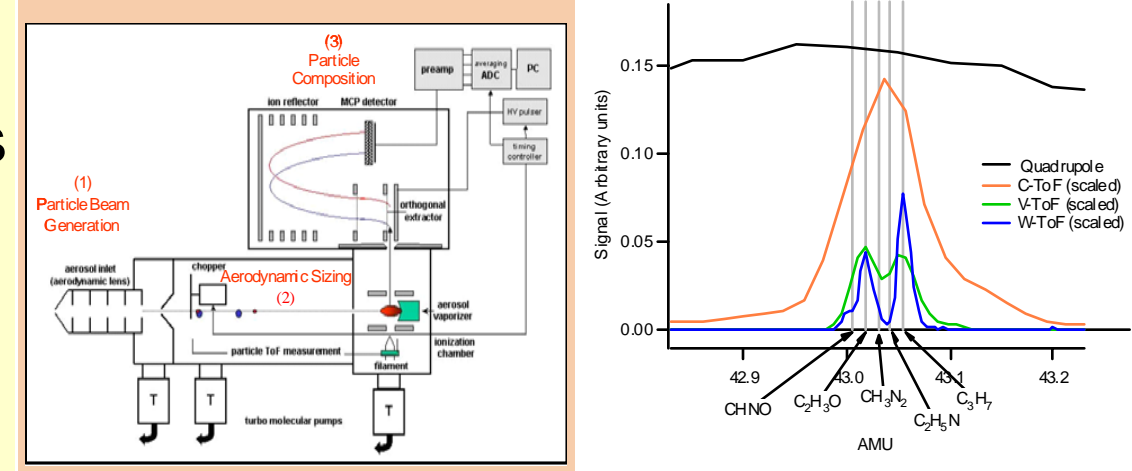
- The Aerosol Mass Spectrometer (AMS) has demonstrated quantitative capabilities and some chemical resolution in *total* organic analysis.



- Above: comparison of AMS and OC mass concentrations during field studies in Pittsburgh and Tokyo.
- Below: principal component analysis of AMS spectra, showing the time series and MS of hydrocarbon-like and oxygenated organics. An analysis of 30+ AMS field experiments is being carried out by CU.

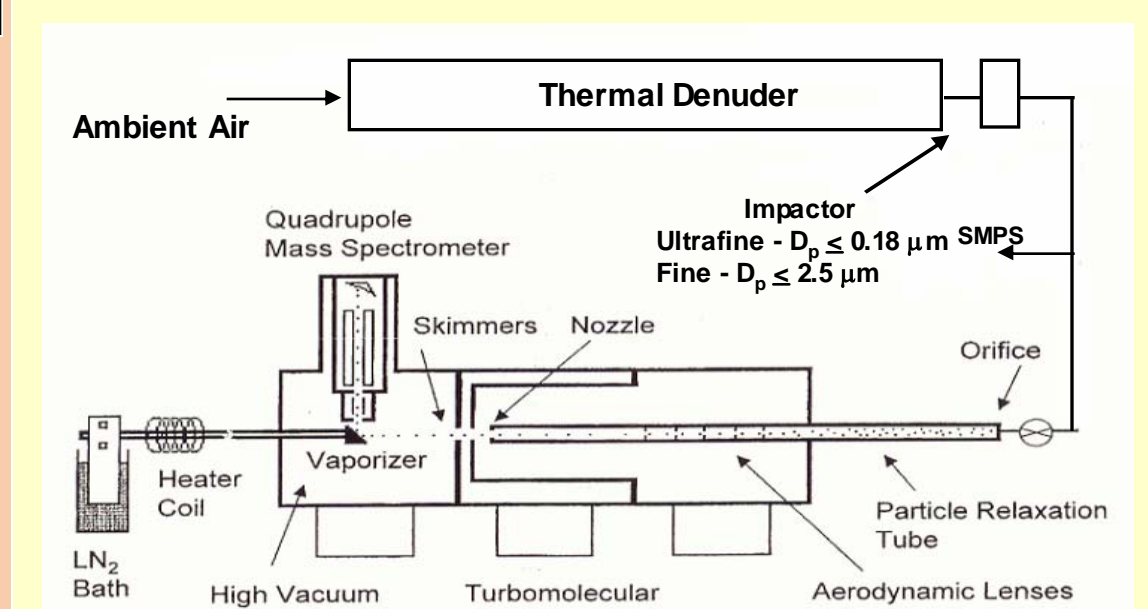


- New AMS developments deployed summer '05: (a) a time-of-flight AMS with increased time resolution, full size-composition capabilities & single-particle analysis; (b) VUV-AMS; (c) high *m/z* resolution.

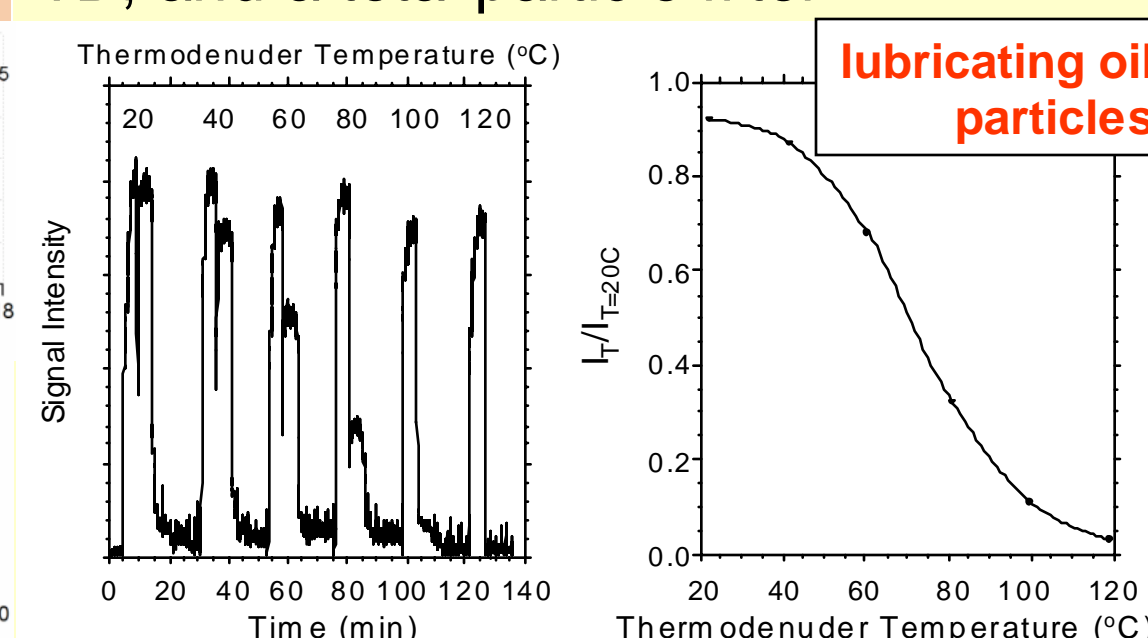


Volatility & Mass Spec

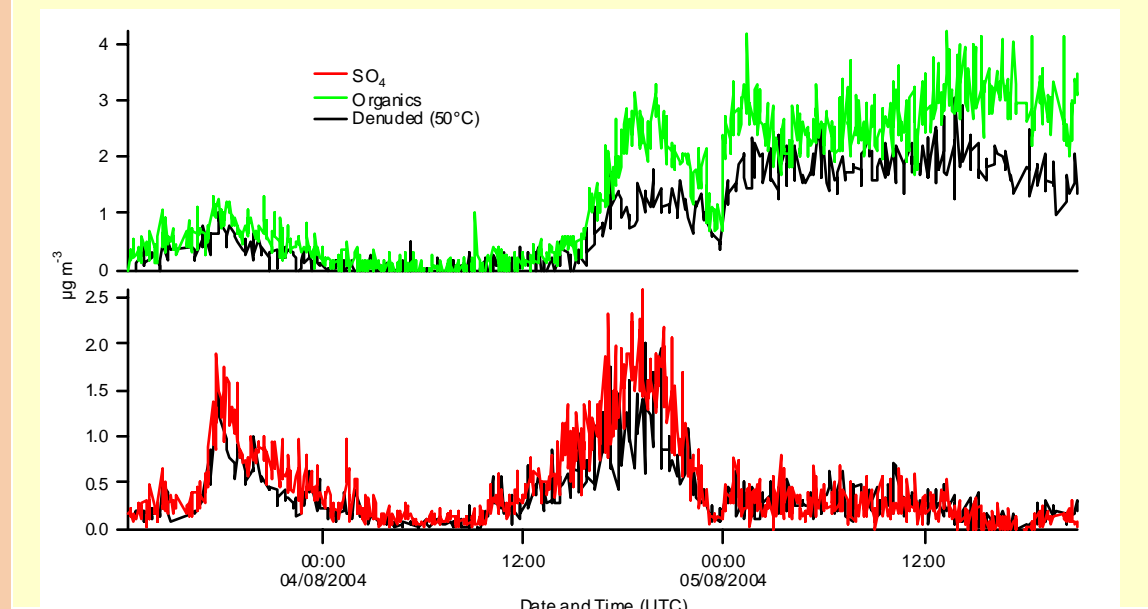
- Simultaneous chemical and volatility analysis increases resolution on the OA aerosol composition and sources. The use of a thermal denuder (TD) with the AMS and Thermal-Desorption Particle Beam Mass Spectrometer (TDPBMS) is being explored by UC Riverside, CU, and Aerodyne under EPA funding.



- Below is the real-time TDPBMS signal alternated between normal sampling, TD, and a total particle filter.

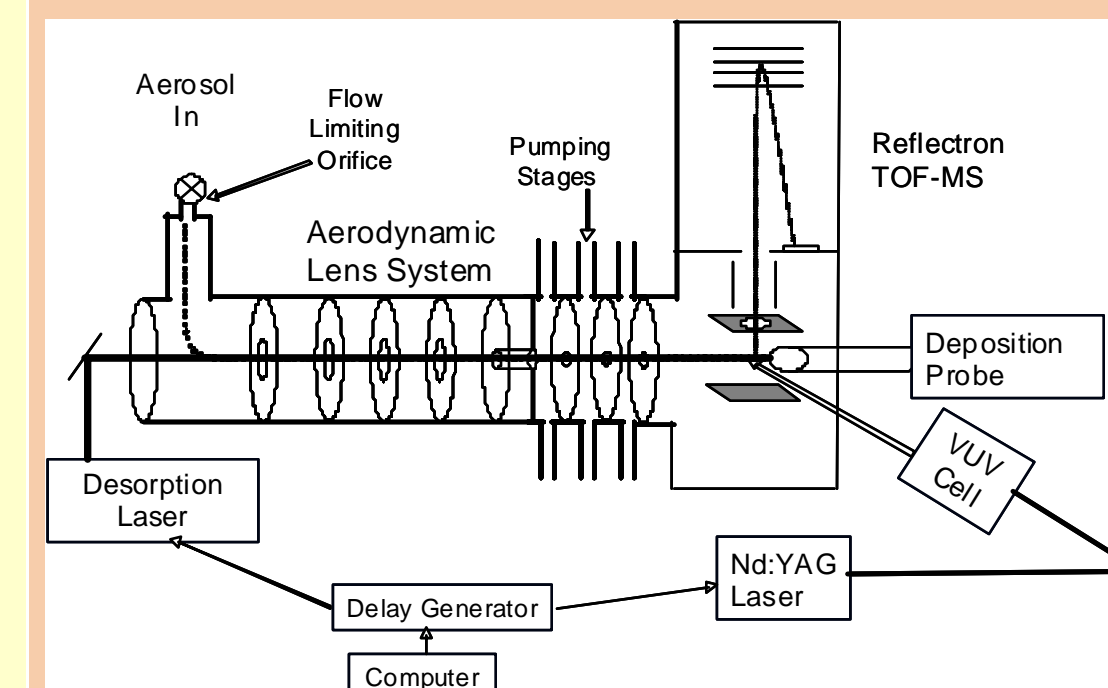


- The results of a field deployment in Nova Scotia, Canada are below. The effect of the TD on organics is much larger than on sulfate.

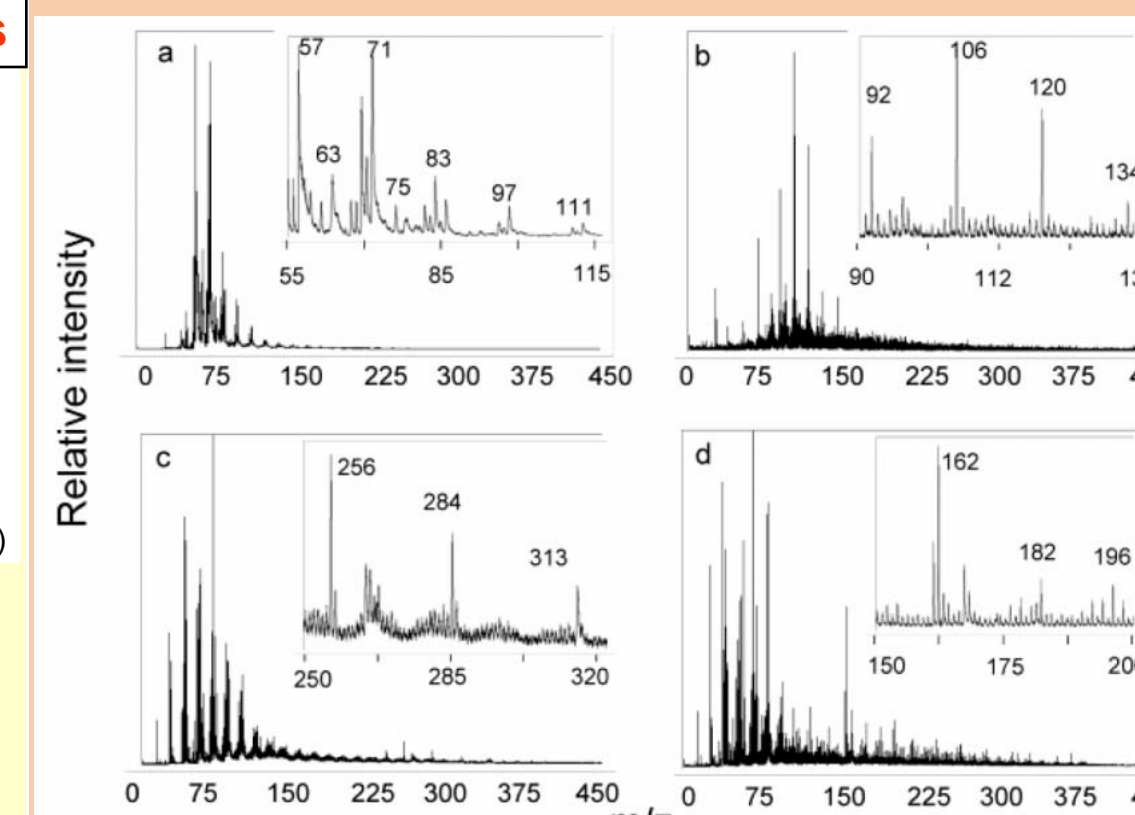


VUV Photoionization + MS

- The use of softer ionization approaches allows the retention of organic molecular information. The Photoionization Aerosol Mass Spectrometer (PIAMS) is being developed by U. Delaware.



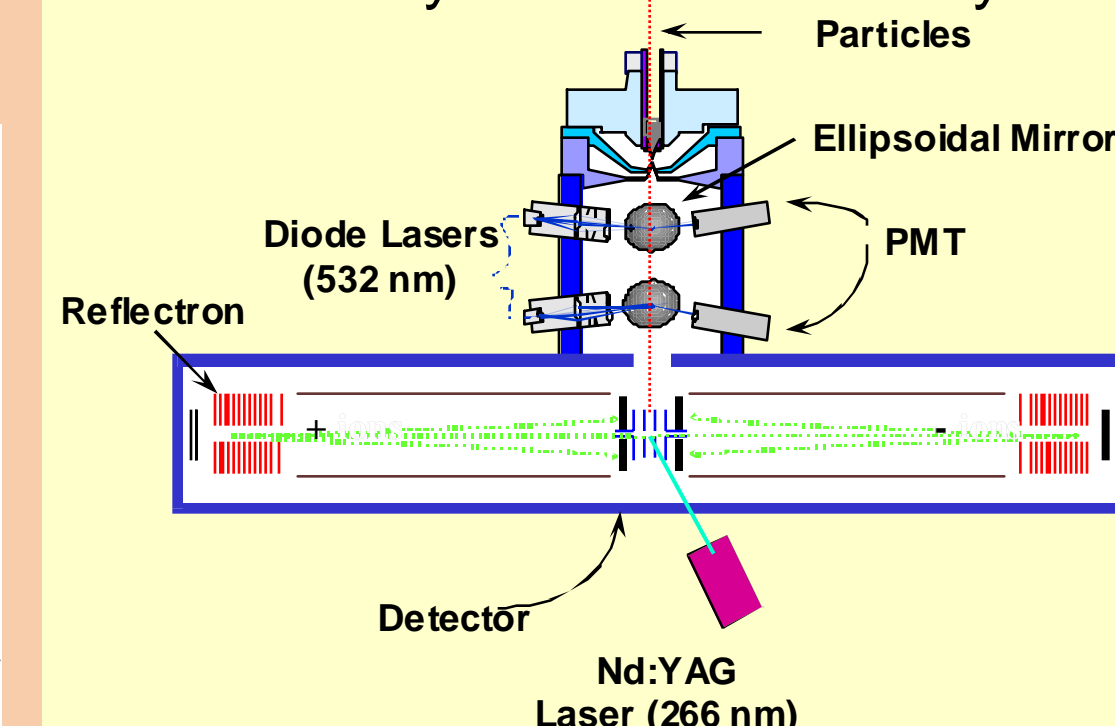
- PIAMS spectra are shown below for (a) diesel engine; (b) gasoline engine; (c) meat cooking; (d) wood burning. Each one shows unique markers that can be used for source identification.



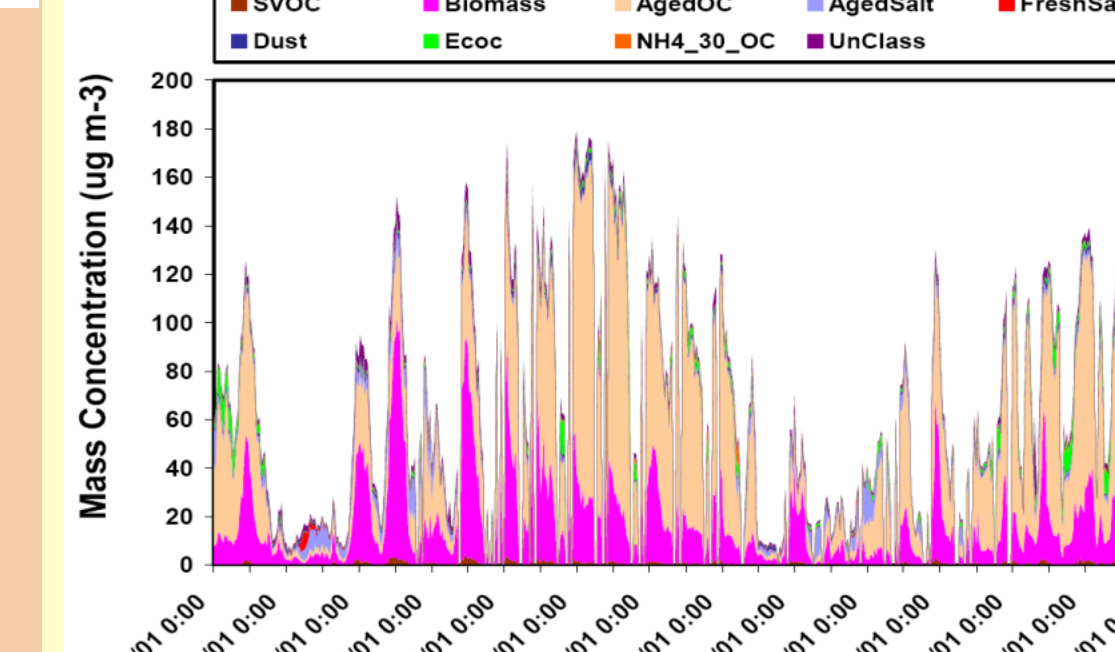
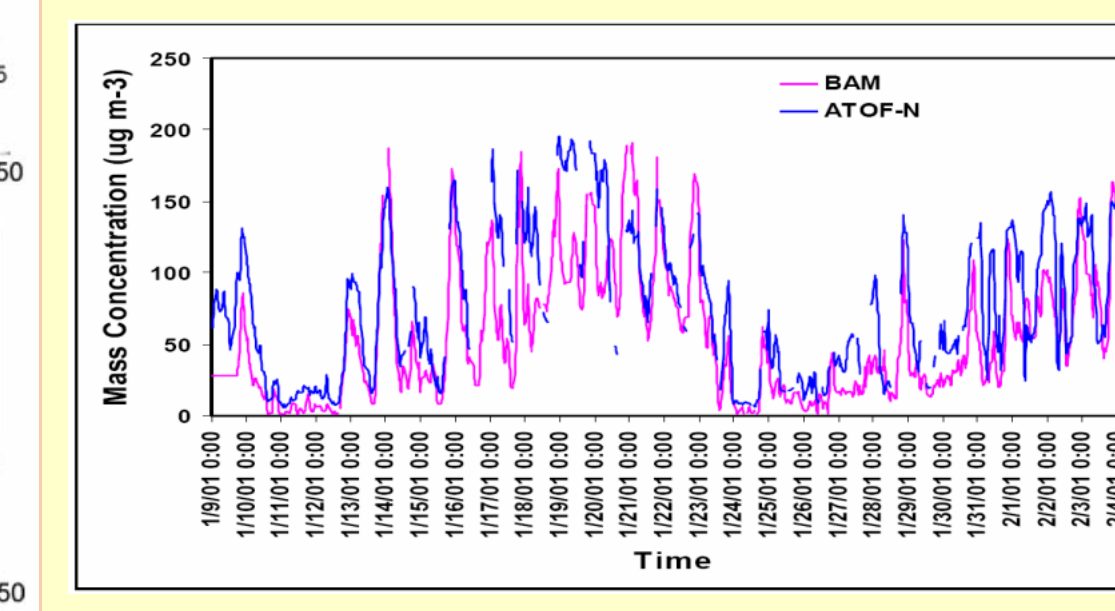
- The PIAMS will be field-deployed for the first time during summer'05. A strategy has been identified for obtaining low detection limits and fast time resolution, based on the use of a particle pre-concentrator. Detection limits of 1 ng m⁻³ for aliphatics and 0.1 ng m⁻³ for aromatics (1-minute samples) are estimated.

Single Particle ATOFMS

- The Aerosol Time-of-Flight Mass Spectrometer (ATOFMS) is capable of analyzing the size and composition of individual particles. This instrument has been recently commercialized by TSI.



- UCSD is pursuing the identification of markers for OA source apportionment and improving the quantification of ATOFMS data. The top plot below indicates reasonable agreement between ATOFMS & BAM (β-attenuation monitor) concentrations. The bottom plot details the sources of the observed concentrations.



Future Directions

- The possibilities of these new techniques are just starting to be explored. The commercialization of the AMS, ATOFMS, and HR-AMS will enable the widespread application of these techniques.
- An improved understanding of the sources of organic aerosols is beginning to be achieved. Improved data analysis techniques are being developed to handle the vast quantities of information.
- These are all research-grade instruments. Work is ongoing for adapting some techniques to routine monitoring and may be only about 3 years away.

Impact and Outcomes

- Progress in organic aerosol analysis in the last few years has been impressive. With continued technique development and field sampling, we are on the verge of *major advances* in our understanding of this component.
- Quantitative analysis of the whole organic aerosol with some chemical resolution and/or source estimation is now possible.
- These advances can be linked to health and visibility studies to help in the identification of the aerosol sources of most concern. A rational control policy needs to be based on the insights from such studies.

Air Quality